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**Brief Reports**

# POWER INJECTION THROUGH ULTRASOUND-GUIDED INTRAVENOUS LINES: SAFETY AND EFFICACY UNDER AN INSTITUTIONAL PROTOCOL

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□ **Abstract—Background: After an index case of contrast-associated compartment syndrome, an urban hospital instituted a protocol limiting high-speed injection to intravenous (IV) lines started proximal to the forearm and testing those lines before contrast injection. Objective: In this article, we estimate the safety and efficacy of high-speed injection using this protocol in patients with IV lines inserted under ultrasound guidance. Methods: In an ambispective study, we enrolled prospective cohorts of ED patients requiring high-speed radiographic contrast media injection (≥3.5 mL/sec) into two groups: those with IV lines placed under ultrasound guidance and those with IV lines placed using traditional inspection and palpation. We also performed a retrospective review involving those groups. In addition, we reviewed hospital records for all patients with compartment syndrome between January 2010 and December 2011. We calculated 95% confidence intervals using normal approximation or exact calculation. Results: Between November 2013 and August 2014, the ED referred 32 patients to the Department of Radiology for computed tomography angiography involving high-speed contrast injection through ultrasound-guided IV lines. Of these, 25 of 32 (78%) had successful injection (7 failed in the Department of Radiology) vs. 26 of 27 (96%) with catheters inserted using traditional methods (risk difference 0.18 [95% confidence interval −0.01 to 0.38]). Based on retrospective records, we estimated 79 additional cases. We found no cases of compartment syndrome during either period, for an incidence estimate of 0 per 100 cases (95% confidence interval 0–3). Conclusion: A hospital policy for high-speed contrast injection through ultrasound-guided IV lines has a safe record. However, 22% of patients with ultrasound-guided IV lines were refused for CT.** © **2016 Elsevier Inc. All rights reserved.**

□ **Keywords—angiography; catheterization; compartment syndromes; contrast media; emergency service; hospital**

## INTRODUCTION

High-speed injection of intravenous (IV) radiographic contrast provides timely diagnosis of a myriad of emergency conditions, including aortic dissection, pulmonary embolism, and subarachnoid hemorrhage. The benefits and risk need to be understood, because high-speed injection can lead to extravasation and, in severe cases, compartment syndrome.

Ultrasound guidance has emerged as a popular solution in situations in which IV access is difficult to establish. Extravasation is common in patients with peripheral IV access, with reported rates between 8% and 27% within the first few hours after placement

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(1–4). Safety data are limited regarding the practice of high-speed injection of contrast through ultrasound-guided IV lines, which sets the stage for variations in policies established by radiology departments. For example, in our city, two nearby hospitals take opposite approaches in their protocols for high-speed injection through ultrasound-guided lines. One, a tertiary care hospital, forbids injection through IV lines inserted proximal to the antecubital fossa; the other, a community, university-affiliated hospital, forbids injection through IV lines inserted distal to the antecubital fossa.

In 1994, in response to a case of contrast-associated compartment syndrome requiring fasciotomy, our urban community university-affiliated hospital adopted a policy requiring aspiration of blood and ease of injection before contrast administration and prohibiting injections distal to the antecubital fossa. In this study, we examine the safety and efficacy of this practice by estimating the incidence of extravasation and compartment syndrome associated with high-speed injection through ultrasound-guided IV lines and comparing the failure rate of those lines with the failure rate of lines started by traditional inspection and palpation.

## METHODS

### *Setting and Population*

The site of this study is an urban community emergency department (ED) with a census of 58,000 patients per year. In 1994, there was a case of extravasation after power injection that resulted in fasciotomy for compartment syndrome. In response, the hospital adopted a power injection protocol, in which the computed tomography (CT) technician is to test the IV line by inspection, aspirate blood, and manually inject 10 mL of saline before starting the procedure. Under this protocol, IV lines inserted under ultrasound guidance were automatically refused if they were inserted distal to the antecubital fossa, so that vulnerable fascial compartments could be avoided. At this hospital, CT angiograms are obtained with a contrast injection rate of 3.5 to 4 mL per second. The catheters used at this hospital are either 3.9 or 4.8 cm in length; the longer one is preferred for ultrasound-guided IV lines.

### *Data Collection*

Our data collection had prospective and retrospective components. We used prospective collection to assess the safety and efficacy of power injection in monitored patients. We used retrospective collection to obtain additional safety data. The periods of interest are summarized in Table 1.

**Table 1. Study Periods of Interest**

| |
|---|
| Retrospective Data Collection (1995–2015) |
| 1995–2015: Ultrasound intravenous power injection (USPI) protocol in use |
| 2010–2011: Retrospective review for cases of compartment syndrome |
| January–September 2010: Retrospective review for cases of USPI |
| Prospective data collection |
| November 2013–August 2014: Emergency department logs cases of USPI |
| November 2013–April 2014: Radiology department notes USPI refusals |
| June–August 2014: Radiology department notes any power injections (including USPI and non-USPI) |

*Prospective collection.* We collected data prospectively between November 2013 and August 2014. During this period, we asked emergency physicians to log any ED patients for whom CT angiography was requested after ultrasound-guided insertion of an IV line. We asked our CT technicians to keep separate logs during two time periods: the first to collect safety data, and the second to collect efficacy data. In period 1 (November 2013–April 2014), we asked the technicians to document any refusals of patients referred for power injection through ultrasound-guided IV lines and the reason for refusal. During period 2 (June–August 2014), we asked them to record the results of all referrals for power injection, including patients with IV lines started using ultrasound guidance and those with lines inserted using inspection and palpation. For ultrasound-guided lines, we recorded whether the line was inserted in or proximal to the antecubital fossa.

*Retrospective collection.* In the retrospective collection, we reviewed records from patients who underwent CT angiography requested in the ED from January 2010 through September 2010, looking for cases in which the angiogram was obtained using contrast administered through an ultrasound-guided IV line. Our intention was to estimate the rate of CT angiograms performed through ultrasound-guided IV lines, in number of cases per month. We also recorded whether compartment syndrome developed in any of the patients who received contrast through these lines.

Because of the possibility that we would not capture cases of extravasation after CT angiograms that were attempted but cancelled, we also reviewed the hospital records of patients who had compartment syndrome or underwent fasciotomy. We requested records with *International Classification of Diseases, 9th revision* codes for compartment syndrome, both traumatic and nontraumatic (i.e., 729.71, 729.72, 958.8, 958.90, 958.91, and 958.92), and those for fasciotomy (i.e., 83.14) from January 2010 through December 2011. We confirmed